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THE ANCIENT LAKES OF WESTERN AMERICA: THEIR DEPOSITS AND DRAINAGE.*

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THE wonderful collections of fossil plants and animal remains brought by Dr. Hayden from the country bordering the Upper Missouri have been shown by his observations, and the researches of Mr. Meek, to have been derived from deposits made in extensive fresh-water lakes; lakes, which once occupied much of the region lying immediately east of the Rocky Mountains, but which have now totally disappeared. The sediments that accumulated in the bottoms of these old lakes show that in the earliest periods of their history they contained salt water, at least that the sea had access to them, and their waters were more or less impregnated with salt, so as to be inhabited by oysters and other marine or estuary mollusks. In due time the continental elevation which brought all the country west of the Mississippi up out of the widespread Cretaceous sea, raised these lake-basins altogether above the sea level and surrounded them with a broad expanse of dry land. Then ensued one of the most interesting chapters in the geological history of our continent, and one that, if fairly written out, could not fail to be read with pleasure by all intelligent persons. The details of

*From Dr. Hayden's forthcoming "Sun Pictures of the Rocky Mountains."

this history are however, in a great measure, yet to be supplied; inasmuch as the great area of our western possessions is still but very partially explored, and it is certain that it forms a great treasure-house of geological knowledge, from which many generations will draw fresh and interesting material before its riches shall be exhausted.

The enlightened measures adopted by our Government for the exploration of the public domain, the organization and thorough equipment of the numerous surveying parties that have traversed the region west of the Mississippi within the last twenty years, together with the more extensive explorations by private enterprise of our great mining districts, have resulted in giving us materials from which an outline sketch can now be made that may be accepted as in all its essential particulars, accurate and worthy of confidence.

It has happened to me to be connected with three of the Government surveys, to which I have referred, and to spend several years in traversing the great area lying between the Columbia River and the Gulf of Mexico. The observations which I have made on the geological structure of our Western Territories supplement, in a somewhat remarkable way, those made by Dr. Hayden, so that taken together, our reports embody the results of a reconnoissance stretching over nearly the whole of our vast possessions west of the Mississippi.

Our knowledge of the geology of this region has also been largely increased by the no less important contributions of other explorers. Among those who deserve most honorable mention in this connection are Mr. George Gibbs, to whom we are indebted for most that we know of the geology of Washington Territory; to Professors W. P. Blake and Thomas Antisell, to Prof. Whitney and the other members of the California Geological Survey; to Baron Richtofen, the lamented Rémond, Drs. Shiel, Wislizenus, and others.

The results obtained by the last, largest and best organized party which has been engaged in Western explorations,

that of Mr. Clarence King, have not yet been given to the public, but from an examination of some of the materials which are to compose the reports of this expedition, I feel justified in saying that it will prove to be among the most important of all the series of explorations of which it forms a part, and that the published results of this expedition will be not only an important contribution to science and our knowledge of our own country, but a high honor to those by whom the work has been performed, and to the Government by which it was organized.

Without going into details or citing the facts or authorities on which our conclusions rest, I will, in a few words, give the generalities of the geological and topographical structure of that portion of our continent which includes the peculiar features that are to be more specially the subject of this paper.

It is known to most persons that the general character of the topography of the region west of the Mississippi has been given by three great lines of elevation which traverse our territory from north to south: the Rocky Mountain Belt, the Sierra Nevada and the Coast Ranges. Of these, the last is the most modern, and is composed, in great part, of Miocene Tertiary rocks. It forms a raised margin along the western edge of the continent, and has produced that "iron bound coast" described by all those who have navigated that portion of the Pacific which washes our shores.

Parallel with the Coast Mountains lies a narrow trough which, in California, is traversed by the Sacramento and San Joachin Rivers, and portions of it have received their names. Further north, this trough is partially filled, and for some distance, nearly obliterated by the encroachment of the neighboring mountain ranges, but in Oregon and Washington it reappears essentially the same in structure as further south, and is here traversed by the Williamette and Cowlitz Rivers.

These two sections of this great valley have now free

drainage to the Pacific, through the Golden Gate and the trough of the Columbia, both of which are channels cut by the drainage water through mountain barriers that formerly obstructed its flow, and produced an accumulation behind them that made these valleys inland lakes; the first of the series I am to describe of extensive fresh-water basins that formerly gave character to the surface of our Western Territory, and that have now almost all been drained away and have disappeared.

East of the California Valley lies the Sierra Nevada; a lofty mountain chain reaching all the way from our northern to our southern boundary. The crest of the Sierra Nevada is so high and continuous that for a thousand miles it shows no passes less than five thousand feet above the sea, and yet, at three points there are gate-ways opened in this wall, by which it may be passed but little above the sea-level. These are the cañons of the Sacramento (Pit River), the Klamath and the Columbia. All these are gorges cut through this great dam by the drainage of the interior of the continent. In the lapse of ages the cutting down of this barrier has progressed to such an extent as almost completely to empty the great water basins that once existed behind it, and leave the interior the arid waste that it is—the only real desert on the North American Continent.

The Sierra Nevada is older than the Coast Mountains, and projected above the ocean, though not to its present altitude, previous to the Tertiary and even Cretaceous ages. This we learn from the fact, that strata belonging to these formations cover its base, but reach only a few hundred feet up its flanks. The mass of the Sierra Nevada is composed of granitic rocks, associated with which are metamorphic slates, proved by the California Survey to be of Triassic and Jurassic age. These slates are traversed in many localities by veins of quartz, which are the repositories of the gold that has made California so famous among the mining districts of the world.

East of the Sierra Nevada we find a high and broad plateau, five hundred miles in width, and from four thousand to eight thousand feet in altitude, which stretches eastward to the base of the Rocky Mountains, and reaches southward far into Mexico. Of this interior elevated area the Sierra Nevada forms the western margin, on which it rises like a wall. It is evident that this mountain belt once formed the Pacific coast; and it would seem that then this lofty wall was raised upon the edge of the continent to defend it from the action of the ocean waves. In tracing the sinuous outline of the Sierra Nevada, it will be seen that its crest is crowned by a series of lofty volcanic cones, and that one of these is placed at each conspicuous angle in its line of bearing, so that it has the appearance of a gigantic fortification, of which each salient and reëntering angle is defended by a massive and lofty tower.

The central portion of the high table lands, to which I have referred, was called by Fremont the Great Basin, from the fact that it *is* a hydrographic basin, its waters having no outlet to the ocean. The northern part of this area is drained by the Columbia, the southern by the Colorado. Of these the Columbia makes its way into the ocean by the gorge it has cut in the Cascade Mountains, through which it flows nearly at the sea level; while the Colorado reaches the Gulf of California through a series of cañons, of which the most important is nearly one thousand miles in length, and from three thousand to six thousand feet in depth. In volume VI. of the Pacific Railroad Reports, I have described a portion of the country drained by the Columbia, and have given the facts that led me to assert that the gorge through which it passes the Cascade Mountains has been excavated by its waters; and that previous to the cutting down of this barrier these waters accumulated to form great fresh-water lakes, which left deposits at an elevation of more than two thousand feet above the present bed of the Columbia. Similar facts were observed in the country drained by the

Klamath and Pit Rivers, and all pointed to the same conclusion.

In all this region I observed certain peculiarities of geological structure that have been remarked by most of those who have traversed the interval between the Sierra Nevada and the Rocky Mountains. In the northern and middle portions of the great table lands the general surface is somewhat thickly set by short and isolated mountain ranges, which have been denominated the "Lost Mountains." These rise like islands above the level of the plain, and are composed of volcanic or metamorphic rocks. The spaces between these mountains are nearly level, desert surfaces, of which the underlying geological structure is often not easily observed. Toward the north and west, however, wherever we come upon the tributaries of the Columbia, the Klamath or Pit Rivers, we find the plateaus more or less cut by these streams and their substructure revealed.

Here the underlying rocks are nearly horizontal, and consist of a variety of deposits varying much in color and consistence. Some are coarse volcanic ash with fragments of pumice and scoria. Others I have in my notes denominated "concrete," as they precisely resemble the old Roman cement and are composed of the same materials. In many localities these strata are as fine and white as chalk, and, though containing little or no carbonate of lime, they have been referred to as "chalk-beds" by most travellers who have visited this region. Specimens of this chalk-like material gave me my first hint of the true history of these deposits. These, collected on the head waters of Pit River, the Klamath, the Des Chutes, Columbia and elsewhere, were transmitted for examination to Professor Bailey, then our most skilled microscopist. Almost the last work he did before his untimely death was to report to me the results of his observation on them. This report was as harmonious as it was unexpected. In every one of the chalk-like deposits to which I have referred he found *fresh-water diatomaceæ*.

From the stratification and horizontality of these deposits, I had been fully assured that they were thrown down from great bodies of water that filled the spaces separating the more elevated portions of the interior basin, and here I had evidence that this water was fresh. Since that time a vast amount of evidence has accumulated to confirm the general view then taken of the changes through which the surface of this portion of our continent has passed. From South-western Idaho and Eastern Oregon I have now received large collections of animal and vegetable fossils of great variety and interest. Of these the plants have been, for the most part, collected by Rev. Thomas Condon, of the Dalles, Oregon, who has exposed himself to great hardship and danger in his several expeditions to the localities in Eastern Oregon, where these fossils are found. The plants obtained by Mr. Condon are apparently of Miocene age, forming twenty or thirty species, nearly all new and such as represent a forest growth as varied and luxuriant as can be now found on any portion of our continent.

The animal remains contained in these fresh-water deposits have come mostly from the banks of Castle Creek, in the Owyhee district, Idaho. The specimens I have received were sent me by Mr. J. M. Adams, of Ruby City. They consist of the bones of the mastodon, rhinoceros, horse, elk and other large mammals, of which the species are probably in some cases new, in others identical with those obtained from the fresh-water Tertiaries of the "Bad Lands" by Dr. Hayden. With these mammalian remains are a few bones of birds and great numbers of the bones and teeth of fishes. These last are cyprinoids allied to *Mylopharodon*, *Micheilus*, etc., and some of the species attained a length of three feet or more. There are also in this collection large numbers of fresh-water shells of the genera *Unio*, *Corbicula*, *Melania* and *Planorbis*.* All these fossils show that at one

*One of the most common is a species of *Tiara* closely resembling an East Indian one, while the genus no longer exists in this continent.

period in the history of our continent, and that geologically speaking quite recent, the region under consideration was thickly set with lakes, some of which were of larger size and greater depth than the great fresh-water lakes which now lie upon our northern frontier. Between these lakes were areas of dry land covered with a luxuriant and beautiful vegetation, and inhabited by herds of elephants and other great mammals, such as could only inhabit a well-watered and fertile country. In the streams flowing into these lakes, and in the lakes themselves, were great numbers of fishes and mollusks of species, which, like the others I have enumerated, have now disappeared. At that time, as now, the great lakes formed evaporating surfaces, which produced showers that vivified all their shores. Every year, however, saw something removed from the barriers over which their surplus water flowed to the sea and, in the lapse of time, they were drained to the dregs. In the Klamath lakes, and in San Francisco, San Pablo and Suisun bays, we have the last remnants of these great bodies of water; while the drainage of the Columbia lakes has been so complete, that in some instances, the streams which traverse their old basins have cut two thousand feet into the sediments which accumulated beneath their waters.

The history of this old lake country, as it is recorded in the alternations of strata which accumulated at the bottoms of its water basins, will be found to be full of interest. For while these strata furnish evidence that there were long intervals when peace and quiet prevailed over this region, and animal and vegetable life flourished as they now do nowhere on the continent, they also prove that this quiet was at times disturbed by the most violent volcanic eruptions, from a number of distinct centres of action, but especially from the great craters which crowned the summit of the Sierra Nevada. From these came showers of ashes which must have covered the land and filled the water so as to destroy immense numbers of the inhabitants of both. These ashes

formed strata which were, in some instances ten or twenty feet in thickness. At other times the volcanic action was still more intense, and floods of lava were poured out which formed continuous sheets, hundreds of miles in extent, penetrating far into the lake-basins, and giving to their bottoms floors of solid basalt. When these cataclysms had passed, quiet was again restored, forests again covered the land, herds dotted its pastures, fishes peopled the waters, and fine sediments abounding in forms of life accumulated in new sheets above the strata of cooled lava. The banks of the Des Chutes River and Columbia afford splendid sections of these lake deposits, where the history I have so hastily sketched may be read as from an open book.

But, it will be said that there are portions of the great central plateau which have not been drained in the manner I have described. For, here are basins which have no outlets, and which still hold sheets of water of greater or less area, such as those of Pyramid Lake, Salt Lake, etc. The history of these basins is very different from that of those already mentioned but not less interesting nor easily read. By the complete drainage of the northern and southern thirds of the plateau through the channels of the Columbia and Colorado, the water surface of this great area was reduced to the tenth or one-hundredth part of the space it previously occupied. Hence, the moisture suspended in the atmosphere was diminished in like degree, and the dry hot air, sweeping over the plains, licked up the water from the undrained lakes until they were reduced to their present dimensions. Now, as formerly, they receive the constant flow of the streams that drain into them from the mountains on the east and west, but the evaporation is so rapid that their dimensions are not only not increased thereby, but are steadily diminishing from year to year. Around many of these lakes, as Salt Lake, for example, just as around the margins of the old drained lakes, we can trace former shore lines and measure the depression of the water level. Many of these lakes

of the Great Basin have been completely dried up by evaporation, and now their places are marked by alkaline plains or "salt flats." Others exist as lakes only during a portion of the year, and in the dry season are represented by sheets of glittering salt. Even those that remain as lakes are necessarily salt, as they are but great evaporating pans where the drainage from the mountains — which always contains a portion of saline matter — is concentrated by the sun and wind until it becomes a saturated solution and deposits its surplus salts upon the bottom.

The southern portion of the great central table land — that which has been denominated the Colorado Plateau — is almost without mountain barriers or local basins, and we, therefore, find upon it fewer traces of ancient lakes, though they are not entirely wanting. It is apparent, however, that this high plateau, which stretches away for several hundred miles west of the Rocky Mountains, was once a beautiful and fertile district. The Colorado draining then, as now, the western ranges of the Rocky Mountains, spread over the surface of this plateau, enriching and vivifying all parts of it. When it reached the western margin of the table land, however, it poured over a precipice or slope five thousand feet in height, into the Gulf of California, which then reached several hundred miles farther north than now. In process of time the power developed by this stupendous fall cut away the rock beneath the flowing water, and formed that remarkable gorge to which I have already referred. This gorge is nearly one thousand miles in length and from three thousand to six thousand feet in depth, and is cut through all the series of sedimentary rocks from the Tertiary to the granite, and has worn out the granite to a depth of from six hundred to eight hundred feet. Just in proportion as the Colorado deepened its channel, the region bordering it became more dry, until ultimately the drainage from the mountains passed through it in what may be even termed "underground channels," and contributed almost nothing

to the moisture of the surrounding country. The reason why the walls of this cañon stand up in such awful precipices of thousands of feet is, that the perennial flow of the stream is derived from far distant mountains; almost no rain falls upon its banks, and when any portion of the bordering cliff has passed beyond the reach of the stream, it stands almost unaffected by atmospheric influences.

On the east of the Rocky Mountains lies the country of the "plains," a region not unlike in its topography to the great plateau of the West, but differing in this: that it is not bordered on the east by a continuous mountain chain; that it slopes gently downward to the Mississippi, and that its eastern half has been so well watered that the valleys have been made broad and all its topographical features softened down. In former times, however, the topographical unity now conspicuous on the plains did not exist, and the surface was marked by a series of great basins which received the flow of water from the Rocky Mountains and formed lakes, less numerous, it is true, but of greater extent than those of the far West. The northern portion of the eastern plateau has been Dr. Hayden's chosen field of exploration for many years; a field he has well tilled, and from which he has obtained a harvest of scientific truth which will form for him an enduring and enviable monument.

Among the most interesting researches of Dr. Hayden in this region, are the studies he has made of the deposits which have accumulated in these great fresh-water basins. The story he has written of his explorations of this district has been so well and fully told that I shall not attempt to repeat it. Suffice it to say, that the series of fresh-water basins discovered by Dr. Hayden in the country bordering the Upper Missouri have proved to be as rich in new and interesting forms of animal and vegetable life as any that have been found upon the earth's surface. The vertebrate remains collected by Dr. Hayden have been studied, described and illustrated by Dr. Liedy, and the splendid monograph which

he has published of these fossils, forms a contribution to paleontology not second in value or interest to that made by Cuvier in his illustrations of the fossils from the Paris basin; nor to that of Falconer and Cautley, descriptive of the fossils of the Sewalik hills of India.

The scarcely less voluminous and interesting collections of fossil plants made by Dr. Hayden have been placed in my hands for my examination. Of these, the first instalments were described and drawn some years since as a contribution to the report of Colonel W. F. Reynolds, U.S.A., a report not yet published by the Government. The descriptions, however, were printed in the Annals of the Lyceum of Natural History of New York, vol. ix, 1868.

The general conclusions drawn from a study of this portion of Dr. Hayden's collections as regards the floras of the Tertiary and Cretaceous periods, the topography and climate of the interior of the continent, form a part of my contribution to Colonel Reynolds' report. Since that report was written, however, very large additions have been made to our knowledge of our later extinct floras, by collections of fossil plants made in different portions of the western part of our continent by Dr. Hayden, Mr. Condon, Dr. Le Conte and myself; and also by the collections made by Mr. W. H. Dall and Captain Howard in Alaska, and by several explorers on the continent of Greenland.

Deferring for the present a comparison of the plants derived from strata of similar age in these widely separated localities, and the inferences deducible from them as regards the physical geography of our continent, I will say that the flora and fauna of the lake deposits on both sides of the Rocky Mountains apparently belong to one and the same geological age, and tell the same story in regard to the topography, climate, conditions and development of animal and vegetable life. There is this striking difference, however, perceptible at the first glance between the fresh-water Tertiaries of the east and west. In Oregon, Idaho and

Nevada, volcanic materials have accumulated in the lake basins to a much greater extent than east of the Rocky Mountains; and we have abundant evidence that during the Tertiary period the western margin of the continent was the scene of far greater volcanic activity than we have any record of in the Rocky Mountain belt.

The deposits formed by the lake basins of the Upper Missouri region are shales, marls and earthy limestones, with immense quantities of lignite, but with almost no traces of volcanic products. The number of fossil plants and animals is much greater there than farther West; and we have, in these deposits, proof that during unnumbered ages this portion of the continent exhibited a diversified and beautiful surface, which sustained a luxuriant growth of vegetation and an amount of animal life far in excess of what it has done in modern times. This condition of things existed long enough for hundreds and even thousands of feet of sediment to accumulate in the bottoms of extensive fresh-water lakes. These lakes were gradually and slowly diminished in area by the filling up of their basins and by the slow wearing away of the barriers over which passed their gently flowing, draining streams. Since the deposition of the fresh-water Tertiaries, which occupy the places of the old lakes, great changes have taken place in the topography of this region by the upheaval of portions of the Rocky Mountain ranges. In some localities these lake deposits are found turned up on edge and resting on the flanks of the mountains which border the plains on the west. It is certain, however, that much of the Rocky Mountain belt existed anterior to this date. We have in these, and many other facts that might be cited, proofs of the truth of the assertion I have elsewhere made that these great mountain chains, though existing at least in embryo from the earliest paleozoic ages, have, since then, been subject to many and varied modifications—that they have been, in fact, hinges upon which the great plates of the continent have turned—lines

of weakness where the changes of level experienced by the continent have been most sensibly felt.

It is a somewhat remarkable fact that the collections of fossil plants made by Dr. Hayden from different localities differ so much among themselves. In every newly discovered plant-bed he has obtained more or less species of which we before had no knowledge, and it is even true that between some of his collections there are no connecting links. It is also true that much of the material he has collected has not yet received the study it needs. From these facts it will be seen that much yet remains to be done before the great interval of time during which this series of fresh-water Tertiaries accumulated can be divided into definite periods, and before we can venture to affirm that a flora of any epoch had such or such a botanical character and, therefore, this or that average annual temperature. Some interesting facts came out, however, at once in the examination of these materials; to these I will briefly refer.

In the beginning of the Cretaceous age, North America, as we know, presented a broad land surface, having a climate similar to the present, and covered with forests consisting, for the most part, of trees belonging to the same genera with those that now flourish upon it. In the progress of the Cretaceous age, the greater part of the continent west of the Mississippi sank beneath the ocean, and the deposits made during the later portions of the Cretaceous age contain a vegetation more tropical in character than that which had preceded it. It seems probable that at this time the lands which existed as such, west of the Mississippi, were islands of limited extent, washed by the Gulf Stream, which apparently had then a course north and west from the Gulf of Mexico to the Arctic Sea.

The earlier Tertiary epochs were, however, marked by an emergence of the continent and a gradual approach to previous and present conditions. This is indicated by the fact that the oldest Tertiary deposits (Eocene?) contain a flora

less like the present than is that of the Miocene or Middle Tertiary. In this category of older deposits with a more tropical flora, I would place the Green River Tertiary beds, those of Mississippi studied by Lesquereux, and those of Brandon, Vermont.

In the Miocene age, the continental surface was broader, the lake basins of the West contained only fresh water, and the land surface was covered with a vegetation very much like that of the present day; a number of Miocene species still existing. The climate of the continent in the Miocene age was much milder than now. Fan-palms then grew as far north as the Yellowstone River, and a flora flourished in Alaska and on Greenland as varied and as luxuriant as now grows along the fortieth parallel. At this time there must have been some sort of land connection between our continent and Europe on the one hand and Asia on the other. The flora of all these regions was essentially the same, and a large number of plants were common to the three continents. In this age the mammalian fauna of our continent exhibited the same remarkable development that it did in Europe and Asia; and over our western plains roved herds of great quadrupeds rivalling in number and variety those that have struck with wonder and surprise every traveller in South Africa.

This state of things seems to have continued through the Pliocene age and up to the time when the climate of the continent was completely revolutioned by the advent of the "Ice period." The change which took place at that time was such as taxes the imagination to conceive of, as much as it taxes the reasoning powers to explain.

We have seen that in the Middle Tertiary age the climate of Alaska and Greenland was that of New York and St. Louis at present. In the next succeeding period, the glacial epoch, the present climate of Greenland was brought down to New York, and all the northern portion of the continent wrapped in ice and snow. This change was undoubtedly

gradual (for nature does not often "turn a corner"), but it is plain that it must have resulted in the gradual driving southward of all the varied forms of animal and vegetable life that were spread over the continent to the Arctic Sea. When glaciers reached as far south as the fortieth parallel it is evident that a cold-temperate climate prevailed in Mexico, and that only in the south of Mexico would the average annual temperature have been what it was previously in the latitude of New York. We must conclude, therefore, that the herds of mammals which once covered the plains of the interior of North America were forced by the advancing cold into such narrow limits in Southern Mexico that nearly all were exterminated. Plants bore their expatriation better; inasmuch as a tree, even of the most gigantic size, will live upon the space occupied by its roots provided the climatic conditions are favorable; while one of the larger mammals would require at least a thousand times this space for its support. As a consequence, we find the present flora of our continent much more like that of the Miocene than is our fauna, though the change to which I have referred seems to have been fatal to quite a number of the most abundant and interesting of our Miocene forest trees. Of these, the *Glyptostrobus* may be taken as an example. This was a beautiful conifer which, in Miocene times, grew all over our continent and over Northern Europe. In the change to the glacial period, however, it was exterminated, both there and here, yet continued to exist in China—where a Miocene colony from America had taken root—and it is growing there at the present time. This great ice-wedge which came down from the north separated very widely many elements in our Miocene flora which have never since been re-united, so that when the storm had passed and better days had come, and the Mississippi Valley and the Atlantic States were re-possessed by the descendants of the Tertiary plants, they were still separated, by many thousand miles, from their brethren which had formerly crossed the now submerged bridge of

Behring's Straits; and thus the two kindreds have been growing, and flowering, and seeding, and dying in each colony far beyond the reach of the other, and developing their peculiarities each in its own way from generation to generation. When now we come to compare the present flora of China and Japan with that of the eastern half of our continent we find the strongest proofs of their intimate relationship. Many of the species are identical, while others are but slightly changed and, on the whole, the differences are less than such as have grown out of separation in human kindred colonies in an infinitely shorter period.

Among the great mammals that formerly inhabited our continent but such as are now extinct, there were some which seem to have bid defiance to the changes I have detailed. These were particularly the mastodon and elephant, both of which were probably capable of enduring great severity of climate. The mammoth we know was well defended from the cold by a thick coat of hair and wool, and was probably capable of enduring a degree of cold as severe as that in which the musk-ox now lives. We know that both these great monsters — the elephant and mastodon — continued to inhabit the interior of our continent long after the glaciers had retreated beyond the upper lakes, and when the minutest details of surface topography were the same as now. This is proven by the fact that we not unfrequently find them embedded in peat in marshes which are still marshes where they have been mired and suffocated. It is even claimed that here, as on the European continent, man was a cotemporary of the mammoth, and that here as there, he contributed largely to its final extinction. On this point, however, more and better evidence than any yet obtained is necessary before we can consider the cotemporaneity of man and the elephant in America as proven. The wanting proof may be obtained to-morrow, but to-day we are without it.

The pictures which geology holds up to our view of North America during the Tertiary ages, are in all respects but

one, more attractive and interesting than could be drawn from its present aspects. Then a warm and genial climate prevailed from the Gulf to the Arctic Sea; the Canadian highlands were higher, but the Rocky Mountains lower and less broad. Most of the continent exhibited an undulating surface; rounded hills and broad valleys covered with forests grander than any of the present day, or wide expanses of rich savannah over which roamed countless herds of animals, many of gigantic size, of which our present meagre fauna retains but a few dwarfed representatives. Noble rivers flowed through plains and valleys, and sea-like lakes broader and more numerous than those the continent now bears diversified the scenery. Through unnumbered ages the seasons ran their ceaseless course, the sun rose and set, moons waxed and waned over this fair land, but no human eye was there to mark its beauty or human intellect to control and use its exuberant fertility. Flowers opened their many-colored petals on meadow and hill-side, and filled the air with their fragrance, but only for the delectation of the wandering bee. Fruits ripened in the sun, but there was no *hand* there to pluck, nor any speaking tongue to taste. Birds sang in the trees, but for no ears but their own. The surface of lake or river was whitened by no sail, nor furrowed by any prow but the breast of the water fowl; and the far-reaching shores echoed no sound but the dash of the waves, and the lowing of the herds that slaked their thirst in the crystal waters.

Life and beauty were everywhere; and man, the great destroyer, had not yet come, but not all was peace and harmony in this Arcadia. The forces of nature are always at war, and redundant life compels abundant death. The innumerable species of animals and plants had each its hereditary enemy, and the struggle of life was so sharp and bitter that in the lapse of ages many genera and species were blotted out forever.

The herds of herbivores — which included nearly all the

genera now living on the earth's surface, with many strange forms long since extinct—formed the prey of carnivores commensurate to these in power and numbers. The coo of the dove and the whistle of the quail were answered by the scream of the eagle; and the lowing of herds and the bleating of flocks come to the ear of the imagination, mingled with the roar of the lion, the howl of the wolf, and the despairing cry of the victim. Yielding to the slow-acting but irresistible forces of nature, each in succession of these various animal forms has disappeared till all have passed away or been changed to their modern representatives, while the country they inhabited, by the upheaval of its mountains, the deepening of its valleys, the filling and draining of its great lakes, has become what it is.

These changes which I have reviewed in an hour seem like the swiftly consecutive pictures of the phantasmagoria or the shifting scenes of the drama, but the æons of time in which they were effected are simply infinite and incomprehensible to us. We have no reason to suppose that *terra firma* was less firm, or that the order of nature, in which no change is recorded within the historic period, was less constant then than now. At the present rate of change—throwing out man's influence—a period infinite to us would be required to revolutionize the climate, flora and fauna, and there is no evidence that changes were more rapid during the Tertiary ages.

Every day sees something taken from the rocky barrier of Niagara; and, geologically speaking, at no remote time our great lakes will have shared the fate of those that once existed at the far West. Already they have been reduced to less than half their former area—and the water level has been depressed three hundred feet or more. This process is likely to go on until they are completely emptied.

The cities that now stand upon their banks will, ere that time, have grown colossal in size, then gray with age, then have fallen into decadence and their sites be long forgotten,

but in the sediments that are now accumulating in these lake-basins will lie many a wreck and skeleton, tree-trunk and floated leaf. Near the city sites and old river mouths these sediments will be full of relics that will illustrate and explain the mingled comedy and tragedy of human life. These relics the geologist of the future will probably gather and study and moralize over as we do the records of the Tertiary ages. Doubtless he will be taught the same lesson we are, that human life is infinitely short, and human achievement utterly insignificant. Let us hope that this future man, purer in morals and clearer in intellect than we, may find as much to admire in the records of this first epoch of the reign of man, as we do in those of the reign of mammals.

THE CHINESE IN SAN FRANCISCO.

BY REV. A. P. PEABODY, D.D.

THE Chinese form from a seventh to a fifth part of the entire population of San Francisco, and are seen in considerable numbers in all parts of California. They mingle with no other race; they learn or profess to know enough and only enough of the English tongue to transact their necessary business with their employers; and in San Francisco they live almost wholly in their own crowded quarters, which constitute in all respects a city by itself.

In the street they are the cleanest and neatest of people. Every man and boy has his *queue* of hair, as long as himself, nicely wrapped in silk braid, and generally rolled round the head. Their principal garment is a dark blue, close-fitting frock. Their shoes are of silk or cloth, with felt soles.

Their houses are dirty beyond description. Scores and even hundreds of them are sometimes huddled together in the same building, with blankets for their only beds, and